CHAPARRAL RESPONSE TO A PRESCRIBED FIRE IN THE MOUNT HAMILTON RANGE, SANTA CLARA COUNTY, CALIFORNIA

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ABSTRACT

Native chaparral flora showed a response to late fall prescribed burning similar to the expected effects of a summer or early fall wildfire but with some important differences. Shrub cover was temporarily reduced by burning, but *Adenostoma fasciculatum* reached preburn cover within three growing seasons. Non-sprouting shrubs recovered more slowly, and repeated prescribed fires would favor *A. fasciculatum*. Native fire-following herb response to this prescribed fire had similar cover to that expected following wildfire, but species diversity was lower than reported from wildfires.

Chaparral ecosystems occupy a large area of California and are important for wildlife habitat, watershed, and human activity (FRRAP 1988). Chaparral periodically burns, which temporarily reduces the shrub canopy and encourages herb growth (Hanes 1977). The natural fire cycle can conflict with human values, therefore land managers have long sought to manage fire occurrence in chaparral (Sampson 1944). Fire management practice since 1900 has changed from unrestricted burning to attempts at complete suppression, eventually culminating in the present policy of prescribed burning for vegetation management.

The general effects of fire on chamise chaparral are well known and have been the subject of several notable research programs (Cooper 1922; Sampson 1944; Biswell et al. 1952; Christensen and Muller 1975; Keeley et al. 1981) and extensive reviews (Hanes 1977; Keeley and Keeley 1988). The mature shrub canopy accumulates fuels, which become highly flammable in late summer and fall, beginning about ten years after burning. The accumulated fuel burns, usually within a few decades, removing woody vegetation. Within a few months after fire, sprouting shrubs begin regrowth and dormant seeds of fire-following herb and suffrutescent shrub seeds germinate. Herbs and suffrutescents dominate the chaparral for a few years until the regeneration of dominant shrubs completes the cycle.

Although the general pattern of fire effects on chaparral is documented, the variability among several important chaparral communities and some species is not (Keeley and Keeley 1988). Addi-

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tionally, the effects of prescribed fires are much more poorly known than the effects of wildfires. Because prescribed fires are usually conducted after the onset of fall rains in late fall, in winter or spring, and not during the normal wildfire season in late summer or early fall, the effects could be considerably different (Leck et al. 1989).

We describe the effects of a late fall prescribed fire on four chaparral communities in the central Coast Range of California.

Study Area

The study was conducted on the 20,000 ha San Felipe Ranch, located in the Mount Hamilton Range in Santa Clara County, California. The study area, known as the Soup Bowl, is a rugged 16 km^2 basin near the confluence of Soup Bowl Creek and the Middle Fork of Coyote Creek. The basin elevation ranges from 800 meters to 1100 meters at the top of Bollinger Ridge. Annual rainfall at the nearest weather station, Mount Hamilton, averages 600 mm, mostly falling as winter rain and occasional snow in this mediterranean climate.

The soils of the area have been mapped and classified as Gaviota gravelly loam, a loamy, mixed, nonacid, themic, Lithic Xerorthent (Lindsey 1974). The vegetation is primarily chaparral, with *Quercus wislizenii* A. De Candolle dominated woodland along streams, and open grassland and *Quercus douglasii* Hook. & Arn. savannah along ridgetops. The area's fire history is poorly documented, with the exception of a wildlife that burned most of the Soup Bowl in summer 1962. No fires occurred between 1962 and the 1983 prescribed burn (Calif. Dept. Forestry and Fire Protection Records).

The plant communities of the Mount Hamilton Range are diverse and poorly described. The flora is also diverse, and species occurrence is well documented (Sharsmith 1945). The area supports a mix of distinct floristic elements from northern and southern California, including a significant (13%) proportion of endemics (Sharsmith 1945). Published studies of the response of chaparral communities in the Inner Coast Range to fire are lacking.

Methods

Community descriptions. In summer 1983, the study area vegetation was classified into community types using dominant species composition (Dunne 1987). Using aerial photos and extensive ground checking, we mapped the types using a 625 m^2 minimum mapping unit. This map then served as the basis for allocating belt transects in a stratified random sample.

Ten community types were classified and mapped. Chaparral communities were defined as having at least 20 percent shrub cover and less than 20 percent tree cover. The four chaparral types were:

chamise chaparral, manzanita chaparral, chamise-ceanothus chaparral, and mixed chaparral.

Sampling and burning. In summer of 1983, 39 permanent belt transects were placed in chaparral types using a stratified random sample with proportional allocation. Spaced at 50 cm intervals along each 25 m transect, fifty points were measured for plant species cover and plant height, stratified into shrub and herb layers. If no plant part occurred on a point, ground surface characteristics were recorded. Each transect marked the center of a 1 m wide belt in which density of woody plant seedlings was recorded. Transects were sampled twice each year, in spring and late summer, beginning in late summer 1983 and continuing through spring 1987.

The prescribed burn was conducted by the California Department of Forestry on 3 November 1983. The treatment was typical of a post-rain, late fall fire, with moderate fuel consumption and patchy ignition. The fire was only partly successful from a management viewpoint, burning 750 of a planned 1500 hectares.

Results

Preburn composition. The four chaparral community types were dominated by brush species preburn, with few herbaceous plants, and some annual grasses in a few transects (Table 1). The annual grass component represents small grassy openings too small to be mapped separately but included in the randomly placed transects.

The chamise chaparral type was dominated by *Adenostoma fasciculatum* Hook. & Arn. (60 percent cover), with lesser amounts of *Ceanothus cuneatus* (Hook.) Nutt. (6 percent cover), and *Arctostaphlos glandulosa* Eastw. (4 percent cover) (Fig. 1A). Manzanita chaparral was dominated by *A. glandulosa* (61 percent), associated with *A. fasciculatum* (29 percent) (Fig. 1B). Chamise-ceanothus chaparral consisted of *A. fasciculatum* (50 percent) and *C. cuneatus* (28 percent) (Fig. 1C). Mixed chaparral included *A. fasciculatum* (61 percent), *Arctostaphylos* spp. (17 percent), and *C. cuneatus* (14 percent) (Fig. 1D).

Fire effects on shrubs. As expected, fire greatly reduced shrub cover and increased herbs on the burned plots (Fig. 2). Patterns of recovery were clear in all four community types by the third post-fire year. In the chamise and manzanita types, the shrub cover on burned transects was insignificantly different from unburned transects after three years since both *Adenostoma fasciculatum* and *Arctostaphylos glandulosa* were vigorous resprouters. For chamise-ceanothus and mixed chaparral types, cover was less than preburn at after three years, but would have reached preburn levels by the fourth year. Species diversity increased in all types, except for chamise chaparral, after the prescribed burn (Fig. 3).

TABLE 1. PRE-BURN PERCENTAGE COVER IN SUMMER 1983 FOR FOUR CHAPARRAL COMMUNITY TYPES.

Community type	Trees	Shrubs	Annual grasses	Perennial grasses	Annual herbs	Perennial herbs	Number of transects
Chamise	<1	73	8	0	<1	0	13
Manzanita	0	90	0	0	0	0	11
Chamise-ceanothus	0	76	7	0	1	0	9
Mixed	0	85	0	0	0	<1	6

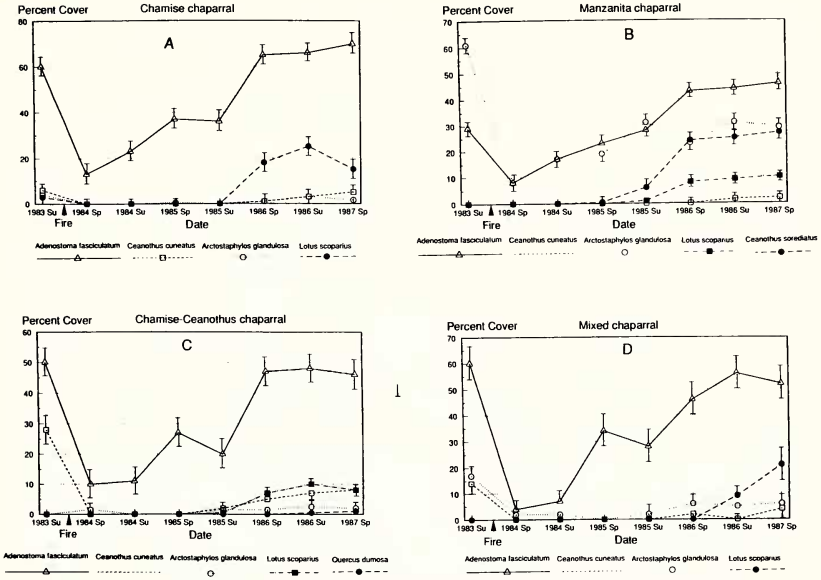

FIG. 1. Changes in cover of shrub species following a fall 1983 prescribed burn in four chaparral community types: A, chamise chaparral; B, manzanita chaparral; C, chamise-ceanothus chaparral; and D, mixed chaparral. Error bars represent ±2 SE of the mean.

Adenostoma fasciculatum showed similar patterns of seedling establishment in all four shrub community types. Increased *A. fasciculatum* cover was accompanied by establishment of an average of 35 *A. fasciculatum* seedlings/m^2 in the first post-burn spring (1984). By summer of 1987, seedling density had declined to only 2 new plants m^{-2}. *Ceanothus cuneatus* established densities of 1 to 5 plants m^{-2} by the first year in each of the four types.

Patterns of shrub recovery differed among community types. In the chamise type, *A. fasciculatum* returned to preburn cover in two years (Fig. 4A). The three most common associated shrubs had recovered by the third year (Fig. 1A). *Lotus scoparius* (Nutt. *in* Torrey & A. Gray) dramatically increased to well above preburn levels by the third spring following the fire.

In the manzanita type, although shrub cover returned to preburn levels by the third year (Fig. 4B), the fire had shifted dominance from *Arctostaphylos* spp. preburn to *Adenostoma fasciculatum* by the second spring following the fire (Fig. 1B). Several uncommon shrub species increased by the second and third years, increasing shrub diversity by the second spring.

In the chamise-ceanothus type, *Adenostoma fasciculatum* and *Lotus scoparius* recovered as in the pure chamise type, *Ceanothus cu-*

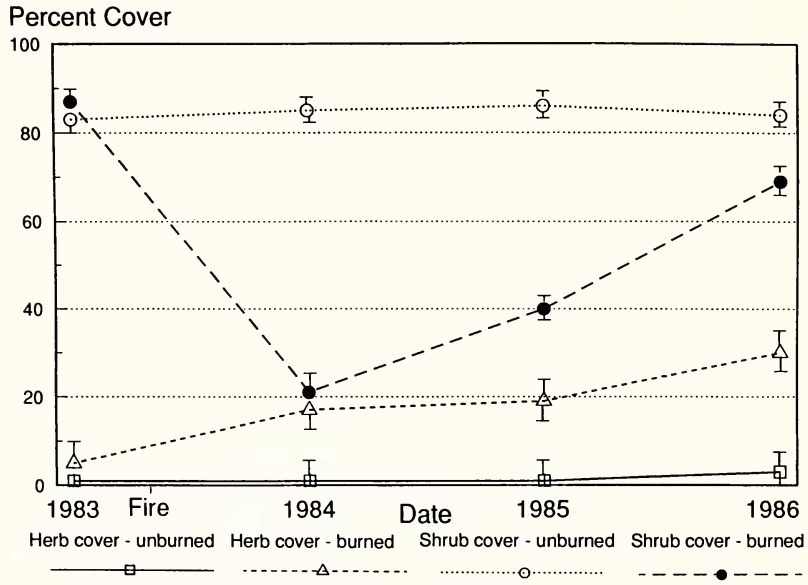

FIG. 2. Changes in cover of chaparral on burned and unburned transects. Error bars represent ±2 SE of the mean.

neatus recovered more slowly, and was at less than half preburn cover in the third spring after fire (Fig. 1C). Shrub cover after three years still had not returned to preburn levels (Fig. 4C).

In the mixed chaparral type, *Adenostoma fasciculatum* and *Lotus scoparius* showed the previously described pattern, with slow overall shrub recovery (Fig. 4D) and slower recovery of *Arctostaphylos* spp. and *Ceanothus cuneatus* (Fig. 1D).

Fire effects on herbaceous cover. Herbaceous cover increased following fire in all types (Fig. 2), least in the manzanita type (Fig. 4B). The different types displayed very different patterns of herb species diversity (Fig. 3). Herb diversity was higher in chamise and chamise-ceanothus types than in manzanita and mixed chaparral types. Few herbaceous species remained in mixed chaparral in 1987.

Fire following herbs *Anthirrhinum multiflorum* Pennell, *Emmenanthe penduliflora* Benth., *Oenothera micrantha* Hornem. ex Spreng., and *Phacelia phaceliodes* (Benth.) Brand were not found preburn, but were common in the first year post-fire. The four fire followers comprised all of the 14 percent total herbaceous cover in the manzanita type and 10 percent of the 14 percent total herbaceous cover in the mixed chaparral type in the first post-fire year. Fire followers were less dominant in the chamise and chamise-ceanothus types at 9 percent of the 22 percent total herbaceous cover and 5 percent of

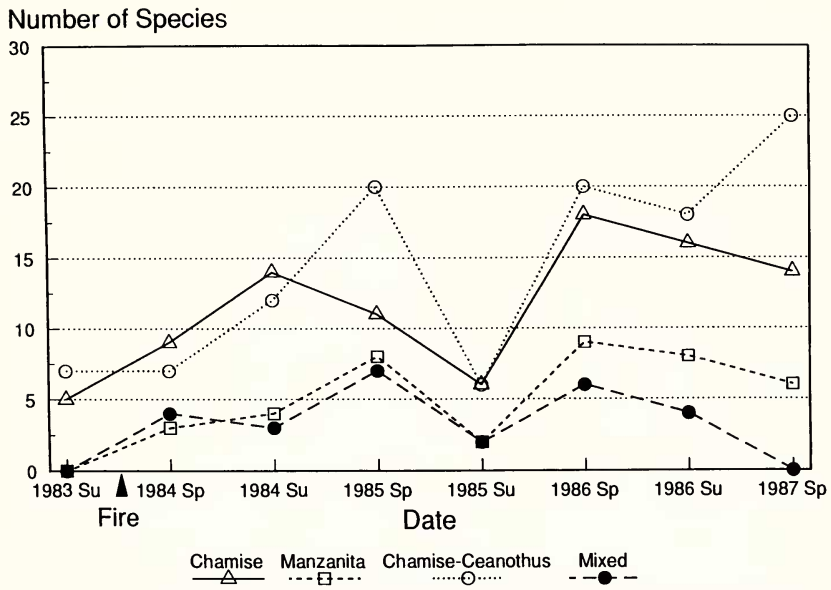

FIG. 3. Changes in number of herbaceous species found in four chaparral types following a fall 1983 prescribed burn.

the 19 percent total herbaceous cover, respectively. The non-fire follower herbaceous cover consisted primarily of the exotic annual grasses *Bromus rubens* L. and *Vulpia myuros* (L.) C. C. Gmel.

The second and third years showed similar herb cover to year one (Fig. 4), but composition shifted to increased cover of annual grasses, with few of the four fire-followers remaining. By spring 1986 fire-followers were absent from manzanita and chamise-ceanothus types, but still comprised 8 percent of the 22 percent total herbaceous cover in mixed chaparral and 3 percent of the 45 percent total herbaceous cover in the chamise-ceanothus type.

DISCUSSION

The general patterns of shrub recovery following burning were similar within the four chaparral community types and to patterns reported in wildfire studies (Keeley and Keeley 1988). However, shrub cover recovered exceptionally fast, *Adenostoma fasciculatum* returned to preburn cover within three years. *Arctostaphylos glandulosa,* where present, also recovered preburn cover within three years. Canopy recovery this rapid suggests a similarly rapid rate for fuel buildup. Under a fuel management program reburning would have to be frequent to keep shrub cover and fuel buildup below hazardous levels.

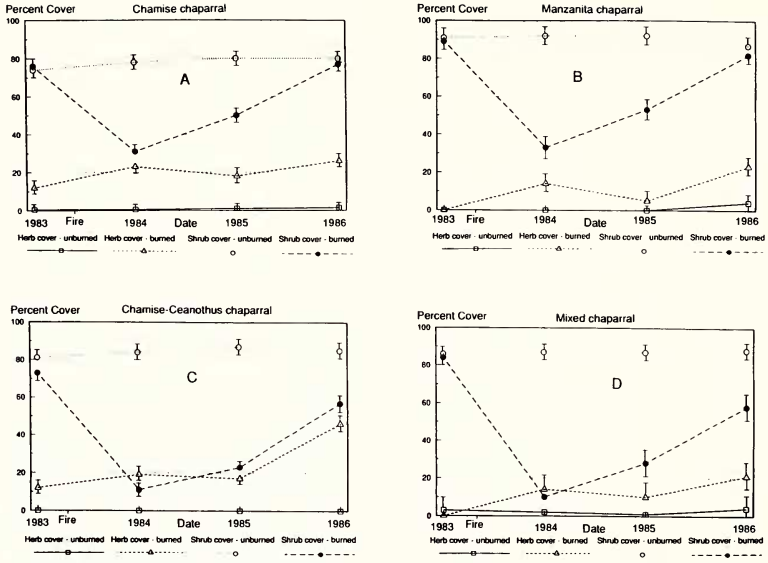

FIG. 4. Changes in relative cover of shrub and herb species following a fall 1983 prescribed burn in four chaparral community types: A, chamise chaparral; B, manzanita chaparral; C, chamise-ceanothus chaparral; and D, mixed chaparral. Error bars represent ±2 SE of the mean.

Shrubs which reproduce from seed like *Ceanothus cuneatus* recovered more slowly than sprouters, reaching only about 25 percent of preburn cover by the third year. The densities of seedling *C. cuneatus* observed in this study were low compared to other studies (Sweeney 1956). In the chamise-manzanita type, this resulted in a probably temporary *A. fasciculatum* dominance. The shorter the fire interval, the greater the expected dominance by the sprouters *A. fasciculatum* and *A. glandulosa,* therefore frequent past fires could be responsible for present *A. fasciculatum* dominance in types which can support greater shrub diversity.

Fire-following herbs appeared following this post-rain fall prescribed burn in a pattern of herb appearance similar to that reported on other chaparral sites (Hanes 1977; Keeley and Keeley 1988). Fewer species made up the fire-following herb flora in this study than reported elsewhere (Keeley and Keeley 1988) although cover was comparable. The fire-following flora is dominated by four species which were abundant in the first preburn year, declined in the second, and were scarce in the third. The pattern showed no evidence that burning in fall after the end of the normal wildfire period negatively affected the few fire-followers present on this site.

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